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(54) Multipoint connected communication system having function of retraining modems provided therein and method of retraining the modems

Mehrpunkt-Datenübertragungssystem mit der Funktion zur Neuinitialisierung der darin eingesetzten Modems und Neuinitialisierungsverfahren der Modems

Système de communication multipoint ayant la fonction d'en réinitialiser les modems et méthode de réinitialisation des modems

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Description

The present invention relates to a system in which a plurality of multipoint-connected slave stations are connected via a down line and an up line to a master station. More particularly, it relates to a technique of retraining a modulator and demodulator (MODEM) unit provided in each of the slave stations.

In a multipoint connected communication system, a plurality of MODEMs provided in slave stations (hereinafter such slave stations will be referred to as "satellite stations" and a MODEM in such a slave station will be referred to as a satellite station MODEM) are multipoint connected via a down line and an up line to a MODEM provided in a master station (hereinafter referred to as a master station MODEM). Access to terminal equipment provided at each satellite station is carried out according to a polling procedure from a host computer provided in the master station and, in turn, data from the terminal equipment to which access is carried out is modulated in the corresponding satellite station and sent to the master station.

In this communication operation, once the master station starts sending the polling data, a demodulation unit in the satellite station MODEM, which receives the polling data via the down line, is brought to a status of normally receiving data (data normally-receiving status). This is because the satellite station MODEM per se is not conscious of the kind of data being received, i. e. it cannot discriminate user data such as the polling data. In this regard, the master station sends a training signal to each of the satellite station MODEMs prior to the sending of the polling data. Upon receipt of the training signal, each satellite station MODEM initializes an automatic gain controller (AGC), an automatic equalizer (AEQ), an automatic carrier phase controller (CAPC), and the like, provided in the corresponding demodulation unit. After the initialization, the satellite station MODEM receives and demodulates user data such as the polling data.

However, where a line trouble or abnormality due to instantaneous breaking or the like occurs in the down line, seen from the demodulation unit in the satellite station MODEM, through which data communication is normally carried out, a disadvantage arises in that operation parameters of the AGC, AEQ, CAPC, and the like, in the satellite station MODEM are changed to abnormal values. As a result of the disadvantage, it takes a long time to restore demodulation processing or operation by the satellite station MODEM to its normal status after the trouble concerned is recovered.

One known MODEM communication system, described in DE-A-2824578, may be considered to comprise data communications apparatus including a master station and a plurality of slave stations connected in multipoint manner to the master station by way of respective down and up lines;

the said master station including a first MODEM unit connected for receiving user data and control information to be transmitted to the slave stations and operable to modulate that user data and control information and to apply the modulated user data and control information to respective main and auxiliary channels of the said down line, the said first MODEM unit also being connected to the said up line for receiving, via respective main and auxiliary channels thereof, modulated user data and control information transmitted by the slave stations to the master station and being operable to demodulate the received user data and control information;

each of the said slave stations including a second MODEM unit connected to the said down line for receiving the user data and control information transmitted to the slave stations by the master station and operable to demodulate that user data and control information, the said second MODEM unit also being connected for receiving user data and control information to be transmitted by its slave station to the master station and being operable to modulate that received user data and control information and to apply the modulated user data and control information respectively to the said main and auxiliary channels of the said up line; and

each of the said slave stations also including abnormality detecting means connected operatively to the said second MODEM unit of the slave station concerned and operable, upon detection of an abnormality in the down line signal received at the slave station concerned, to transmit a predetermined signal to the said master station via the said auxiliary channel of the up line.

In this system, a fault in the receive line (down line) connection can be detected by a slave station MODEM which sends a mayday signal to the master station via the auxiliary (control) channel of the up line, so as to alert the master station to the fault. However, there is no provision in the master station equipment for causing the master station MODEM to respond automatically to this mayday signal by sending out a retraining signal.

DE-A-2532414 describes a point-to-point MODEM communication system, in which there is no "master-slave" relationship between two identical MODEMs A and B. In this system, MODEM A has a signal quality monitoring circuit which, upon detecting a bad quality signal received from MODEM B, sends a re-equalization command to the transmitter in modem A to cause that transmitter to transmit a re-equalization sequence to MODEM B. MODEM B then responds to this received re-equalization sequence by transmitting a re-equalization sequence back to MODEM A, thereby enabling the MODEM A receiver components to retrain. However, this retraining method requires the line from A → B to be retrained as well as the faulty line from B → A, even though no fault probably exists in the A → B line. Thus,

transmission of data from MODEM A to MODEM B is stopped whilst retraining is occurring, thereby reducing data throughput in the system.

Accordingly, a technique is strongly demanded in which, even if a trouble occurs in the down line, the demodulation processing by the satellite station MODEM can be quickly restored to its normal status after recovery of the trouble.

According to a first aspect of the present invention, there is provided data communications apparatus including a master station and a plurality of slave stations connected in multipoint manner to the master station by way of respective down and up lines;

the said master station including a first MODEM unit connected for receiving user data and control information to be transmitted to the slave stations and operable to modulate that user data and control information and to apply the modulated user data and control information to respective main and auxiliary channels of the said down line, the said first MODEM unit also being connected to the said up line for receiving, via respective main and auxiliary channels thereof, modulated user data and control information transmitted by the slave stations to the master station and being operable to demodulate the received user data and control information;

each of the said slave stations including a second MODEM unit connected to the said down line for receiving the user data and control information transmitted to the slave stations by the master station and operable to demodulate that user data and control information, the said second MODEM unit also being connected for receiving user data and control information to be transmitted by its slave station to the master station and being operable to modulate that received user data and control information and to apply the modulated user data and control information respectively to the said main and auxiliary channels of the said up line; and

each of the said slave stations also including abnormality detecting means connected operatively to the said second MODEM unit of the slave station concerned and operable, upon detection of an abnormality in the down line signal received at the slave station concerned, to transmit a predetermined signal to the said master station via the said auxiliary channel of the up line;

characterised in that the said predetermined signal is a retraining request signal, indicating that the slave station concerned requests a retraining signal from the master station, produced when the said abnormality detecting means detects that the down line signal quality has fallen below a predetermined threshold value; and

in that the master station includes retraining command means connected operatively to the first MODEM unit and operable upon receipt of such a retraining request signal from one of the slave stations to cause the first MODEM unit to transmit such a retraining signal via the said down line.

Such apparatus can quickly restore demodulation processing in each of the slave station MODEMs to a respective normal status after a recovery of trouble in the down line.

The master station system may further comprise a storing unit for storing past record information concerning abnormality detection in the satellite stations and information on execution time of the retraining, obtained through the first MODEM unit, whereby the retraining command unit refers to the storing unit upon receipt of a new request for retraining and, based on the past record information on retraining, determines whether it should command the new retraining or not.

Also, the retraining command unit may comprise a unit for disregarding the request for retraining where another retraining is requested before the time required for a previous retraining elapses, or where the master station receives a plurality of requests for the retraining from one particular satellite station.

According to a second aspect of the present invention, there is provided a method of retraining a MODEM unit in a slave station of data communications apparatus in which a plurality of such slave stations are connected in multipoint manner to a master station by way of a down line, having respective main and auxiliary channels for transmitting user data and control information respectively from the master station to the slave stations, and an up line having respective main and auxiliary channels for transmitting user data and control information from the slave stations to the master station, which method comprises:

in the slave station having the said MODEM unit, monitoring for an abnormality in the down line signal received at the slave station and, if such an abnormality is detected, transmitting a predetermined signal to the master station via the said auxiliary channel of the up line; and

in the said master station, monitoring for receipt via the said up line of such a predetermined signal from one of the slave stations;

characterised in that the said predetermined signal is a retraining request signal, indicating that the slave station concerned requests a retraining signal from the master station, and is produced by the slave station when it detects that the down line signal quality has fallen below a predetermined threshold value;

and in that upon receipt of the said retraining request signal the master station automatically transmits such a retraining signal via the down line to the slave stations, thereby to bring about retraining of the said MODEM unit.

Reference will now be made, by way of example, to the accompanying drawings, in which:

Fig. 1 is a block diagram illustrating a constitution of a typical multipoint connected communication system;

Fig. 2 is a block diagram illustrating the fundamental constitution of data communications apparatus embodying the present invention;

Fig. 3 is a block diagram illustrating a constitution of a master station MODEM shown in Fig. 2 according to one embodiment of the present invention;

Fig. 4 is a diagram for use in illustrating an example of the allocation of frequencies in a main channel and a sub-channel in the Fig. 2 apparatus;

Fig. 5 is a block diagram illustrating a constitution of a satellite station MODEM shown in Fig. 2 according to an embodiment of the present invention;

Fig. 6 is a circuit diagram illustrating a constitution of parts of the MODEM shown in Fig. 5;

Fig. 7 is a timing chart for explaining the retraining operation in apparatus embodying the present invention; and

Figs. 8A and 8B are flow charts representing the operations of the MODEMs shown in Figs. 3 and 5.

For a better understanding of the preferred embodiment according to the present invention, the problems in the prior art will be explained with reference to Fig. 1.

Figure 1 illustrates a constitution of a typical multipoint connected communication system.

In the illustration, reference 10A denotes a master station MODEM and references 12A-1 to 12A-3 denote satellite station MODEMs connected in multipoint connection and connected via a down line 100 and an up line 200. The master station MODEM 10A transmits a polling modulation signal via the down line 100 to the satellite station MODEMs 12A-1 to 12A-3 in accordance with a predetermined polling procedure from a host computer 38.

The polling modulation signal transmitted from the master station MODEM 10A is demodulated by the satellite station MODEMs 12A-1 to 12A-3 and then sent to the corresponding terminal equipments 36-1 to 36-3, and any one of the terminal equipments which has identified access to itself outputs a response data. For example, assuming that the terminal equipment 36-1 outputs the response data. In this case, the corresponding satellite station MODEM 12A-1 modulates the response data to transmit the modulated data via the up line 200 to the master station MODEM 10A and, in turn, the master station MODEM 10A demodulates the modulated data and outputs the demodulated data to the host computer 38.

In the above operation, when the master station MODEM 10A starts the polling operation for the satellite station MODEMs 12A-1 to 12A-3, the former first transmits a training signal to the latter. Upon receipt of the training signal, each of the satellite station MODEMs 12A-1 to 12A-3 initializes circuits such as AGC, AEQ, CAPC, and the like, which are provided in the corresponding demodulation unit (not shown) and, in combination, have a function of correcting deterioration of the lines. By this initialization, the circuits set their operation parameters to values which are adapted to factors of the line deterioration and set differently in different satellite stations. After the setting of the operation parameters, the master station MODEM 10A sends polling data to the satellite station MODEMs 12A-1 to 12A-3.

On the other hand, when each of the satellite station MODEMs 12A-1 to 12A-3 sends data in response to the polling data to the master station MODEM 10A, each satellite station MODEM first sends a training signal to initialize a demodulation unit in the master station MODEM and then modulates the response data to send the modulated data to the master station MODEM.

In the above multipoint connected communication system, where a line trouble due to instantaneous breaking or the like occurs in the down line 100 through which the modulated signal such as the polling data from the master station MODEM 10A is normally transmitted, each demodulation unit in the satellite station MODEMs 12A-1 to 12A-3 controls the respective operation parameters to correct factors of the deterioration caused by the line trouble.

However, the ability of each MODEM to correct the factors of the line deterioration is limited and thus it is very difficult to completely remove the line trouble even if the operation parameters are controlled. As a result, each of the operation parameters in the demodulation units is changed to an abnormal value which is out of the range of acceptability.

Accordingly, when the line trouble concerned is recovered, the demodulation unit in the respective satellite station MODEM is in an abnormal operation status, and employs data received after the recovery and carries out the initializing operation to gradually restore its normal status. As for the initializing operation by means of the ordinary data, however, it takes longer time to restore the demodulation processing to its normal status after the recovery of trouble, compared with that by means of the training signal. In particular, the higher the operation speed of the MODEM becomes, the longer the time required for recovery by means of the ordinary data becomes.

Therefore, the prior art multipoint connected communication system has a drawback in that, after the trouble in the down line is recovered, it is impossible to restart data communication quickly.

Figure 2 illustrates the fundamental constitution of the multipoint connected communication system according to the present invention.

In the illustrated system, a plurality of multipoint connected satellite station MODEMs 12-1 to 12-n are connected via a down line 100 and an up line 200 to a master station MODEM 10. The master station MODEM

10 includes a main modulation unit 14 for modulating user data to transmit the modulated data at a relatively high speed by means of a main channel of the down line 100, a sub-modulation unit 16 for modulating various control information to transmit the modulated data at a relatively low speed by means of a sub-channel (auxiliary channel) of the down line 100, a main demodulation unit 26 for demodulating user data from a modulation signal received in a main channel of the up line 200, and a sub-demodulation unit 28 for demodulating various control information from a modulation signal received in a sub-channel (auxiliary channel) of the up line 200. On the other hand, each of the satellite station MODEMs 12-1 to 12-n includes a main demodulation unit 18 for demodulating user data from a modulation signal received in the main channel of the down line 100, a sub-demodulation unit 20 for demodulating various control information from a modulation signal received in the sub-channel of the down line 100, a main modulation unit 22 for modulating user data to transmit the modulated data at a relatively high speed by means of the main channel of the up line 200, and a sub-modulation unit 24 for modulating various control information to transmit the modulated data at a relatively low speed by means of the sub-channel of the up line 200.

Furthermore, each of the satellite station MODEMs 12-1 to 12-n includes an abnormality detecting unit 30, operatively connected to the main demodulation unit 18, for controlling the sub-modulation unit 24 to request the master station MODEM 10 to re-send a training signal when the abnormality detecting unit 30 detects an abnormality from the quality of a signal received at the main demodulation unit 18. On the other hand, the master station MODEM 10 includes a storing unit 34 for storing past record information concerning abnormality detection in the satellite stations and information on execution time of the retraining, obtained through the sub-demodulation unit 28, and a retraining command unit 32, operatively connected to the sub-demodulation unit 28, for referring to the storing unit 34 and commanding the main modulation unit 14 to send the training signal when the sub-demodulation unit 28 receives a signal indicating the request for re-sending of the training signal from any one of the satellite station MODEMs 12-1 to 12-n.

Furthermore, a host computer 38 is connected to the main modulation unit 14 and main demodulation unit 26, and each of a plurality of terminal equipments 36-1 to 36-n is connected to the main demodulation unit 18 and main modulation unit 22 in the corresponding satellite station MODEM 12-1 to 12-n, respectively.

Figure 3 illustrates a constitution of the master station MODEM 10 as an embodiment of the present invention. In the illustration, the same references as those used in Fig. 2 indicate like constituent elements and thus the explanation thereof is omitted.

Referring to Fig. 3, a mixer 40 is provided between the down line 100 and the main modulation unit 14 and sub-modulation unit 16. In the present embodiment, the down line 100 is constituted such that, as shown in Fig. 4, a main channel used for high speed transmission of a modulation signal of user data is allocated to the higher frequency region of the transmission frequency band of 0.3 to 3.4 [kHz] and a sub-channel used for low speed transmission of various control information between MODEMs is allocated to the lower frequency region thereof. For example, the transmission speed in the main channel is 9,600 bits per second [bps], while that in the sub-channel is 75 [bps].

The main modulation unit 14 receives user data, i. e., polling data via a host interface 44 from the host computer 38, divides the polling data into bit data corresponding to one modulation corresponding to the modulation speed of 9,600 [bps], and translates the divided data into signal point coordinates on a complex plane by means of a mapping circuit or the like. The unit 14 then amplitude-modulates real components and imaginary components with respect to cos ωt and sin ωt, respectively, and synthesizes the real and imaginary components to output to the mixer 40.

The modulating function of the sub-modulation unit 16 is basically the same as that of the main modulation unit 14. The sub-modulation unit 16 modulates various control information data between MODEMs and then synthesizes real and imaginary components to output to the mixer 40.

The mixer 40 mixes a modulation signal of the main channel output from the main modulation unit 14 with a modulation signal of the sub-channel output from the sub-modulation unit 16, and sends the mixed output to the down line 100.

A separation filter 42 is provided between the up line 200 and the main demodulation unit 26 and sub-demodulation unit 28. The separation filter 42 separates a modulation signal transmitted via the up line 200 from one of the satellite station MODEMs into modulation signals of the main channel and sub-channel, respectively (see Fig. 4).

The main demodulation unit 26 demodulates an analog modulation signal of the main channel separated through the separation filter 42, converts the demodulated analog signal into a digital signal, inputs the demodulated digital signal to a digital signal processor [DSP] (not shown), and effects processing of correcting factors of deterioration in the lines. Concretely, the DSP is provided with a phase jitter removing circuit including AGC, AEQ, CAPC and a prediction filter (PRDF). Namely, the DSP keeps the receiving signal level constant by means of the AGC, removes interference components between signal signs by means of the AEQ, removes frequency offsets and phase errors by means of the CAPC, and removes phase jitter components by means of the PRDF.

After the DSP provided in the main demodulation unit 26 completes the processing of correcting the factors of the line deterioration, a decision circuit (not shown) refers to a table data and decides a right signal

point. The decided signal point coordinates are converted by means of a mapping circuit into rows of data bits corresponding to one modulation and, finally, rows of data bits corresponding to every modulation are sequentially linked and then output to the host interface 44. Namely, the user data obtained by the demodulation of the modulation signal transmitted via the up line 200 from one of the satellite station MODEMs is sent via the host interface 44 to the host computer 38.

The demodulating function of the sub-demodulation unit 28 is basically the same as that of the main demodulation unit 26. Namely, the sub-demodulation unit 28 corrects the factors of the line deterioration by means of the DSP from a modulation signal of the sub-channel separated through the separation filter 42 and then decides a right signal point. The decided signal point coordinates are converted by means of a mapping circuit into data of 2 bits corresponding to one modulation and, finally, data of 2 bits of every modulation are sequentially linked and then output to the host interface 44.

Also, the master station MODEM 10 is provided with a control unit 320, which is connected to the sub-modulation unit 16 and sub-demodulation unit 28 and controls the units 16, 28 to transmit the various control information between the master station MODEM and satellite station MODEMs by way of the sub-channels of the down line 100 and the up line 200.

Furthermore, the control unit 320 includes a retraining command unit, which commands the main modulation unit 14 to send a training signal when the sub-demodulation unit 28 receives a signal indicating a request for re-sending of the training signal from the satellite station side. Also, a storing unit 34 is operatively connected to the control unit 320 to store past record information concerning abnormality detection in the satellite station MODEMs and information on execution time of the retraining.

Figure 5 illustrates a constitution of the satellite station MODEM 12-i as an embodiment of the present invention. In the illustration, the same references as those used in Fig. 2 indicate like constituent elements and thus the explanation thereof is omitted.

Referring to Fig. 5, a separation filter 46 is provided between the down line 100 and the main demodulation unit 18 and sub-demodulation unit 20, and a monitor 302 is operatively connected to the main demodulation unit 18 and a control unit 300 is operatively connected to the monitor 302 and the MODEM unit (18,20,22,24). The monitor 302 and control unit 300 correspond to the abnormality detecting unit 30 shown in Fig. 2. Note, the separation filter 46 has the same function as that of the separation filter 42 in the master station MODEM 10 (see Fig. 3) and thus the explanation thereof is omitted.

The monitor 302 forms a signal indicating quality of the receiving signal based on a decision error indication signal detected by a decision circuit (not shown in Fig. 5) provided in the main demodulation unit 18, and monitors the formed signal. When the level of the monitored signal falls below a predetermined threshold level, the monitor 302 outputs an abnormality detection signal.

Figure 6 illustrates a circuit constitution of the main parts, i.e., the monitor 302 and part of the main demodulation unit 18, provided in the satellite station MODEM 12-i of Fig. 5.

Referring to Fig. 6, the main demodulation unit 18 is provided with an automatic equalizer (AEQ) 52 for removing interference components between signs of the signal received through the down line 100, an automatic carrier phase controller (CAPC) 54 for removing frequency offsets and phase errors contained in an output of the AEQ 52, a decision circuit 56 for deciding a right signal point from an output of the CAPC 54, and a subtracter 58 for detecting a different between input and output signals of the decision circuit 56. The decision circuit 56 is constituted by a hard decision circuit which decides a right signal point based on table data, or a soft decision circuit employing a Viterbi decoding circuit which decides a right signal point based on a trellis coding in the transmitting equipment side, or by a combination of both of the decision circuits.

An output signal of the subtracter 58 is hereinafter referred to as a decision error indication signal, which is fed back to the AEQ 52, and input to an integrator 60 in the monitor 302 and integrated therein. The integrated decision error indication signal is input to each of comparators 62 and 64 and compared with predetermined threshold levels Th0 and Th1, respectively. For example, assuming that an output of the integrator 60 is within a range of 0 to 1.0, the threshold level Th0 of the comparator 62 is set to, e.g., 0.5 and the threshold level Th1 of the comparator 64 is set to, e.g., 0.1. Note, the nearer the output of the integrator 60 comes to 1.0, the better the quality of the receiving signal becomes.

The comparator 62 outputs a detection signal SQD of "H" level indicating a detection of lowering in the quality of the receiving signal when the level of the integrated decision error indication signal falls below the threshold level Th0 (=0.5). On the other hand, the comparator 64 outputs an alarm signal CJT of "H" level indicating occurrence of unrestorable trouble or abnormality when the level of the integrated decision error indicated signal falls below the threshold level Th1 (=0.1).

Referring again to Fig. 5, when the abnormality detection signal output from the monitor 302 is input to the control unit 300, the control unit 300 judges that a line trouble due to instantaneous breaking or the like occurs in the down line 100, and supplies the sub-modulation unit 24 with a retaining request signal consisting of an addresss of the corresponding satellite station and abnormality occurrence indication data.

A mixer 48 is provided between the up line 200 and the main modulation unit 22 and sub-modulation unit 24. The mixer 48 has the same function as that of the mixer 40 in the master station MODEM 10 (see Fig. 3) and thus the explanation thereof is omitted. Also, data terminal equipment 50 is provided between the corre-

sponding external terminal equipment 36-i and the main modulation unit 22 and main demodulation unit 18.

The terminal equipment 36-i forms response data based on discrimination of a polling call from the master station and feeds the response data via the data terminal equipment 50 to the main modulation unit 22. The main modulation unit 22 modulates the response data and sends the modulated data via the mixer 48 to the up line 200. On the other hand, the sub-modulation unit 24 modulates the retraining request signal output from the control unit 300 by means of the sub-channel of the up line 200 and sends the modulated signal via the mixer 48 to the up line 200.

Next, the retraining operation in the system of the present invention will be explained with reference to the timing chart shown in Fig. 7.

First, when power is supplied to the master station MODEM 10 and the satellite station MODEMs 12-1 to 12-n, the system is brought to its setup status. At times t1 to t2, the main modulation unit 14 in the master station MODEM 10 transmits the training signal, i.e., the modulation signal of training data, via the down line 100 to the main demodulation unit 18 provided in each of the multipoint connected satellite station MODEMs 12-1 to 12-n. Upon receipt of the training signal, the corresponding main demodulation unit 18 initializes the AEQ 52, CAPC 54 and decision circuit 56 therein (see Fig. 6) and brings them to a set status of operation parameters for correcting the factors of the line deterioration.

When the sending of the training signal is completed at time t2, the host computer 38 supplies the main modulation unit 14 in the master station MODEM 10 with polling data (down-stream message data) for access to the satellite stations according to the predetermined polling procedure. The main modulation unit 14 in turn sends the polling data (down-stream message data) to the down line 100.

In the transmission status of the polling data (down-stream message data) from the master station MODEM 10, the monitor 302 in the satellite station MODEM 12-i (see Fig. 5) monitors presence or absence of occurrence of abnormality based on the decision error indication signal obtained from the main demodulation unit 18.

In the monitoring status of the occurrence of abnormality, for example, assuming that the quality of the receiving signal in the main demodulation unit 18 is lowered due to instantaneous breaking in the down line 100 and, based on the detection signal SQD from the comparator 62 (see Fig. 6), the abnormality is detected at time t3. In this case, after the lapse of a predetermined time from the detection of abnormality, the control unit 300 supplies the sub-modulation unit 24 with the retraining request signal consisting of the address ADD of the corresponding satellite station and the abnormality occurrence indication data DATA. The sub-modulation unit 24 in turn informs the master station MODEM 10 of the retraining request.

A signal indicating the retraining request, which is carried out by means of the sub-channel of the up line 200, is demodulated by the sub-demodulation unit 28 in the master station MODEM 10 at time t4 and then fed to the control unit 320.

When the control unit 320 receives the retraining request signal consisting of the satellite station address ADD and the abnormality occurrence indication data DATA from the satellite station side, it refers to the storing unit 34 based on the satellite station address ADD and reads the past record information concerning abnormality detection in the satellite station concerned and the information on the retraining execution time.

Based on the read information, the control unit 320 disregards the retraining request under certain conditions. One condition is when another retraining is requested before the time required for the previous retraining elapses. Another condition is when the master station receives a plurality of requests for the retraining from an identical satellite station. In the latter case, the master station MODEM 10 can judge that the plurality of requests are due to trouble in the hardware of the satellite station MODEM concerned, or due to unrestorable trouble in the lines.

Where the conditions for disregarding the retraining request are not found based on results of the reference to the storing unit 34, the control unit 320 controls the main modulation unit 14 to forcibly terminate the modulation of the host data at time t5. Then, at times t5 to t6, the retraining operation of sending the training signal again to the down line 100 is carried out.

When the retraining signal is transmitted from the master station MODEM 10 via the down line 100 to each of the satellite station MODEMs 12-1 to 12-n at times t5 to t6, the main demodulation unit 18 in the satellite station MODEM which detected abnormality initializes the AEQ 52, CAPC 54, and the like (see Fig. 6). As a result, even if the operation parameters are changed to abnormal values due to the instantaneous breaking in the down line 100 and thus the main demodulation unit 18 is brought to an abnormal status, it is possible to quickly restore the demodulation processing to its normal status. When the sending of the retraining signal is completed at time t6, the main demodulation unit 18 in the satellite station MODEM concerned carries out its normal demodulation operation based on the polling data (down-stream message data) from the host computer 38.

On the other hand, as for the other satellite station MODEMs which do not detect abnormality, the transmission of the polling data (down-stream message data) from the host computer 38 is temporarily interrupted during the sending of the retraining signal and thus the initialization by the retraining signal is forcibly carried out. Accordingly, it is possible to reduce the sending time of the retraining signal to a minimum and thus increase the efficiency of utilization of the system network.

Also, the master station MODEM 10 can analyze

the statuses of the satellite station MODEMs 12-1 to 12-n based on the retraining request from each MODEM. In this regard, it is possible to inform a network service processor [NSP] (not shown) provided on the side of the master station MODEM 10 of information on satellite stations in which abnormality occurs and the nature of the abnormality, and cause the NSP to analyze the information and then indicate the results.

Finally, the retraining method of the present invention will be explained with reference to the flow charts shown in Figs. 8A and 8B. Note, steps 701 to 704 represent the processings in the satellite station MODEM and steps 705 to 713 represent the processings in the master station MODEM.

At step 701, the monitor 302 monitors the status of the down line 100, i.e., presence or absence of abnormality in the down line 100. At a next step 702, the monitor 302 judges whether the abnormality is present (YES) or not (NO). If the result is YES, the control proceeds to step 703 and, if the result is NO, the control returns to step 701. At step 703, the control unit 300 informs the sub-modulation unit 24 of the contents of the abnormality. At a next step 704, the sub-modulation unit 24 informs the master station MODEM 10 of the contents of the abnormality via the up line 200.

At step 705, the sub-demodulation unit 28 monitors an alarm from the satellite station MODEM or MODEMs. At a next step 706, the judgement of whether the alarm is detected (YES) or not (NO) is carried out. If the result is YES, the control proceeds to step 707 and, if the result is NO, the control returns to step 705. At step 707, the control unit 320 reads the past record information on line troubles and retraining operations from the storing unit 34. At a next step 708, the control unit 320 judges whether the satellite station MODEM equipment concerned is normal (YES) or not (NO). If the result is YES, the control proceeds to step 709 and, if the result is NO, the control proceeds to step 711. At step 711, the control indicates "abnormality" of the satellite station MODEM equipment to the outside. After this step, the control comes to an "END".

On the other hand, at step 709, the control unit 320 judges whether the down line 100 is normal (YES) or not (NO). If the result is YES, the control proceeds to step 710, at which the retraining operation is carried out with aid of the control unit 320 and main modulation unit 14. After this step, the control returns to step 705. On the other hand, if the result of step 709 is NO, the control proceeds to step 712. At step 712, the control analyzes contents of "abnormality" of the line and indicates the analyzed result to the outside. At a next step 713, the control stores the analyzed result in the storing unit 34. After this step, the control returns to step 705.

As explained above, according to the present embodiment, abnormality of a satellite station MODEM occurring due to trouble in the down line is immediately informed to the master station and, in turn, the training signal is transmitted again from the master station to the down line. Therefore, it becomes possible to quickly restore the satellite station MODEM concerned to its normal status after recovery of the trouble. This contributes to an increase in the efficiency of utilization of the system network.

Also, since the recovery of the trouble is possible by the retraining processing, it is possible to increase the transmission speed of the down-stream message data from 9,600 [bps], for example, to 19,200 [bps] at which a recovery is difficult in case of ordinary data communication.

Also, since each of the satellite stations informs the master station of the retraining request by means of the sub-channel of the transmission line, an advantage is obtained in that ordinary data transmission using the main channel is not subject to influence by the retraining request.

Furthermore, the master station which received the retraining request refers to the past record information con erning abnormality detection in the satellite stations and the information on the retraining execution time. In this case, where the master station has received a plurality of requests for retraining from one particular satellite station it can judge that the requests are not due to the line trouble, but due to trouble in the hardware of the satellite station MODEM. Therefore, it is possible to cancel the execution of unnecessary retrainings and thus minimize a lowering in the line efficiency due to retraining operations.

Although the present invention has been disclosed and described by way of one embodiment, it is apparent to those skilled in the art that other embodiments and modifications of the present invention are possible without departing from the essential features thereof as defined in the appended claims.

Claims

1. Data communications apparatus including a master station and a plurality of slave stations connected in multipoint manner to the master station by way of respective down and up lines (200, 100);

   the said master station including a first MODEM unit (10) connected for receiving user data and control information to be transmitted to the slave stations and operable to modulate that user data and control information and to apply the modulated user data and control information to respective main and auxiliary channels of the said down line (100), the said first MODEM unit (10) also being connected to the said up line (200) for receiving, via respective main and auxiliary channels thereof, modulated user data and control information transmitted by the slave stations to the master station and being operable to demodulate the received user data

and control information;
each of the said slave stations including a second MODEM unit (12-i) connected to the said down line (100) for receiving the user data and control information transmitted to the slave stations by the master station and operable to demodulate that user data and control information, the said second MODEM unit (12-i) also being connected for receiving user data and control information to be transmitted by its slave station to the master station and being operable to modulate that received user data and control information and to apply the modulated user data and control information respectively to the said main and auxiliary channels of the said up line (200); and
each of the said slave stations also including abnormality detecting means (30) connected operatively to the said second MODEM unit (12-i) of the slave station concerned and operable, upon detection of an abnormality in the down line signal received at the slave station concerned, to transmit a predetermined signal to the said master station via the said auxiliary channel of the up line;
characterised in that the said predetermined signal is a retraining request signal, indicating that the slave station concerned requests a retraining signal from the master station, produced when the said abnormality detecting means (30) detects that the down line signal quality has fallen below a predetermined threshold value (Th0/Th1); and
in that the master station includes retraining command means (32) connected operatively to the first MODEM unit (10) and operable upon receipt of such a retraining request signal from one of the slave stations to cause the first MODEM unit to transmit such a retraining signal via the said down line.

2. Data communications apparatus as claimed in claim 1, wherein said master station further includes a storing means (34) for storing past record information concerning abnormality detection in the slave stations and information on execution time of the retraining, obtained via the first MODEM unit;
the said retraining command means (32) being operable to refer to the storing means upon receipt of such a retraining request signal and, based on the past record information on retraining, to determine whether or not it should bring about transmission of the retraining signal.

3. Data communications apparatus as claimed in claim 2, wherein said retraining command means (32) comprises means for disregarding such a retraining request signal when it is received before the time required for a previous retraining has elapsed, or when the master station receives a plurality of retraining request signals from one particular slave station.

4. Data communications apparatus as claimed in any preceding claim, wherein said abnormality detecting means (30) comprise a monitor circuit (302) for monitoring presence or absence of an abnormality in the down line and a control means (300) responsive to an output signal of the monitor circuit, indicating the presence of an abnormality, to cause the second MODEM unit (12-i) in the slave station concerned to transmit the retraining request signal to the master station.

5. Data communications apparatus as claimed in any preceding claim, wherein

the said first MODEM unit (10) comprises a first main modulation unit (14) for transmitting such master station user data at a relatively high speed by means of the said main channel of the down line (100), a first sub-modulation unit (16) for transmitting such master station control information at a relatively low speed by means of the said auxiliary channel of the down line (100), a first main demodulation unit (26) for demodulating such slave station user data from a modulation signal received via the said main channel of the up line (200), and a first sub-demodulation unit (28) for demodulating such slave station control information from a modulation signal received via the said auxiliary channel of the up line (200), and
each of the said second MODEM units (12-i) comprises a second main demodulation unit (18) for demodulating the master station user data from a modulation signal received via the main channel of the down line (100), a second sub-demodulation unit (20) for demodulating the master station control information from a modulation signal received via the said auxiliary channel of the down line (100), a second main modulation unit (22) for transmitting the slave station user data at a relatively high speed by means of the main channel of the up line (200), and a second sub-modulation unit (24) for transmitting the slave station control information at a relatively low speed by means of the said auxiliary channel of the up line (200).

6. A method of retraining a MODEM unit in a slave station of data communications apparatus in which a plurality of such slave stations are connected in multipoint manner to a master station by way of a down line (100), having respective main and auxiliary channels for transmitting user data and control

information respectively from the master station to the slave stations, and an up line (200) having respective main and auxiliary channels for transmitting user data and control information from the slave stations to the master station, which method comprises:

in the slave station having the said MODEM unit (12-i), monitoring for an abnormality in the down line signal received at the slave station and, if such an abnormality is detected, transmitting a predetermined signal to the master station via the said auxiliary channel of the up line (200); and
in the said master station, monitoring for receipt via the said up line of such a predetermined signal from one of the slave stations;
characterised in that the said predetermined signal is a retraining request signal, indicating that the slave station concerned requests a retraining signal from the master station, and is produced by the slave station when it detects that the down line signal quality has fallen below a predetermined threshold value;
and in that upon receipt of the said retraining request signal the master station automatically transmits such a retraining signal via the down line to the slave stations, thereby to bring about retraining of the said MODEM unit.

7. A method as claimed in claim 6, wherein

the slave station transmits with the retraining request signal information concerning the abnormality in the down line detected thereby; and
the master station stores the transmitted information, as well as information concerning retraining execution time in the slave stations, and, when a retraining request signal is received from one of the slave stations, reads the stored information relating to that slave station to determine therefrom whether or not the down line is normal and, if so, transmits such a retraining signal to the slave stations via the down line but, if not, does not transmit the retraining signal.

8. A method as claimed in claim 7, wherein if, following receipt of the retraining request signal, it is determined that the down line is abnormal, the information transmitted by the said one slave station concerning the abnormality is analyzed and the results of the analysis are output by the master station.

9. A method as set forth in claim 7 or 8, wherein, following receipt of the retraining request signal, the master station also determines from the stored information concerning abnormality detection in the said one slave station whether or not the said one slave station equipment is functioning normally and, when the equipment concerned is determined to be functioning abnormally, indicates abnormality thereof.

Patentansprüche

1. Daten-Kommunikationsgerät mit einer Hauptstation und einer Vielzahl von Unterstationen, die in einer multipoint-Art mit der Hauptstation über jeweilige Abwärts-und Aufwärts-Leitungen (200, 100) verbunden sind,

wobei die Hauptstation eine erste MODEM-Einheit (10) enthält, die zum Empfangen von Anwenderdaten und Steuerinformationen, welche zu den Unterstationen zu übertragen sind, angeschlossen ist und welche so betrieben werden kann, um diese Anwenderdaten und Steuerinformationen zu modulieren, und um die modulierten Anwenderdaten und Steuerinformationen an jeweilige Haupt-und Hilfs-Kanäle der Abwärts-Leitung (100) anzulegen, und die erste MODEM-Einheit (10) auch an die Aufwärts-Leitung (200) angeschlossen ist, um über die jeweiligen Haupt-und Hilfs-Kanäle derselben modulierte Anwenderdaten und Steuerinformationen zu empfangen, welche durch die Unterstationen zu der Hauptstation gesendet werden und die so betreibbar ist, um die empfangenen Anwenderdaten und Steuerinformationen zu demodulieren,
wobei jede der Unterstationen eine zweite MODEM-Einheit (12-i) enthält, die an die Abwärts-Leitung (100) angeschaltet ist, um die Anwenderdaten und die Steuerinformationen zu empfangen, die durch die Hauptstation zu den Unterstationen gesendet werden, und die so betreibbar ist, um diese Anwenderdaten und Steuerinformationen zu demodulieren, und
wobei die zweite MODEM-Einheit (12-i) auch so angeschaltet ist, um die Anwenderdaten und die Steuerinformationen zu empfangen, die durch deren Unterstation zu der Hauptstation zu senden sind, und die so betreibbar ist, um die empfangenen Anwenderdaten und Steuerinforamtionen zu modulieren und die modulierten Anwenderdaten und Steuerinformationen jeweils an die Haupt-und Hilfs-Kanäle der Aufwärts-Leitung (200) anzulegen, und
wobei jede der Unterstationen auch eine Abnormität-Detektoreinrichtung (30) enthält, die betriebsmäßig mit der zweiten MODEM-Einheit (12-i) der in Betracht stehenden Unterstation angeschaltet ist und nach der Detektion eine

Abnormität in dem Abwärtsleitung-Signal, welches an der in Betracht stehenden Unterstation empfangen wird, so betrieben werden kann, um ein vorbestimmtes Signal über den Hilfskanal der Aufwärts-Leitung zu der Hauptstation zu senden,
dadurch **gekennzeichnet**, daß das vorbestimmte Signal aus einem Umschulungs-Anfragesignal besteht, welches anzeigt, daß die in Betracht gezogene Unterstation ein Umschulungs-Signal von der Hauptstation anfragt,welches erzeugt wird, wenn die Abnormität-Detektoreinrichtung (30) detektiert, daß die Qualität des Abwärtsleitung-Signals unter einen vorbestimmten Schwellenwert (Th0/Th1) abgefallen ist, und
daß die Hauptstation eine Umschulungs-Befehlsgabeeinrichtung (32) enthält, die betriebsmäßig mit der ersten MODEM-Einheit (10) verbunden ist und nach dem Empfang eines derartigen Umschulungs-Anfragesignals von einer der Unterstationen so betreibbar ist, um die erste MODEM-Einheit zu veranlassen, ein derartiges Umschulungssignal über die Abwärts-Leitung zu senden.

2. Daten-Kommunikationsgerät nach Anspruch 1, bei dem die Hauptstation ferner eine Speichereinrichtung (34) enthält, um vergangene Aufzeichnungs-Informationen hinsichtlich einer Abnormität-Feststellung in den Unterstationen und Informationen hinsichtlich der Ausführungszeit der Umschulung (retraining) zu speichern, die über die erste MODEM-Einheit erhalten wurden,
wobei die Umschulung-Befehlsgabeeinrichtung (32) so betreibbar ist, um auf die Speichereinrichtung nach Empfang eines derartigen Umschulung-Anfragesignals zuzugreifen und basierend auf den vergangenen Aufzeichnungs-Informationen hinsichtlich der Umschulung zu bestimmen, ob sie das Aussenden des Umschulungssignals bewirken sollte oder nicht.

3. Daten-Kommunikationsgerät nach Anspruch 2, bei dem die Umschulung-Befehlsgabeeinrichtung (32) eine Einrichtung enthält, um ein derartiges Umschulung-Anfragesignal außer acht zu lassen, wenn dieses empfangen wird bevor die Zeit verstrichen ist, die für ein früheres Umschulen erforderlich war, oder wenn die Hauptstation eine Vielzahl von Umschulung-Anfragesignalen von einer bestimmten einen Unterstation empfängt.

4. Daten-Kommunikationsgerät nach irgendeinem der vorhergehenden Ansprüche, bei dem die Abnormität-Detektoreinrichtung (30) eine Monitorschaltung (302) enthält, um das Vorhanden sein oder Fehlen einer Abnormität in der Abwärts-Leitung zu überwachen, und eine Steuereinrichtung (300) umfaßt, die auf ein Ausgangssignal der Monitorschaltung anspricht, welches das Vorhandensein einer Abnormität anzeigt, um die zweite MODEM-Einheit (12-i) in der in Betracht bezogenen Unterstation zu veranlassen, das Umschulungs-Anfragesignal zu der Hauptstation zu senden.

5. Daten-Kommunikationsgerät nach irgendeinem der vorhergehenden Ansprüche, bei dem

die erste MODEM-Einheit (10) eine erste Haupt-Modulationseinheit (14) enthält, um derartige Hauptstation-Anwenderdaten mit einer relativ hohen Geschwindigkeit mit Hilfe des Hauptkanals der Abwärts-Leitung (100) zu übertragen, eine erste Sub-Modulationseinheit (16) enthält, um derartige Hauptstation-Steuerinformationen mit einer relativ niedrigen Geschwindigkeit mit Hilfe des Hilfskanals der Abwärts-Leitung (100) zu übertragen, eine erste Haupt-Demodulationseinheit (26) umfaßt, um die Hilfsstation-Anwenderdaten aus einem Modulationssignal zu demodulieren, welches über den Hauptkanal der Aufwärts-Leitung (200) empfangen wurde, und eine erste Sub-Demodulationseinheit (28) umfaßt, um derartige Unterstation-Steuerinformationen aus einem Modulationssignal zu demodulieren, welches über den Hilfskanal der Aufwärts-Leitung (200) empfangen wurde, und
bei dem jede der zweiten MODEM-Einheiten (12-1) eine zweite Haupt-Demodulationseinheit (18) umfaßt, um die Hauptstation-Anwenderdaten aus einem Modulationssignal zu demodulieren, welches über den Hauptkanal der Abwärts-Leitung (100) empfangen wurde, eine zweite Sub-Demodulationseinheit (20) enthält, um die Hauptstation-Steuerinformationen aus einem Modulationssignal zu demodulieren, welches über den Hilfskanal der Abwärts-Leitung (100) empfangen wurde,eine zweite Haupt-Modulationseinheit (22) umfaßt, um die UnterstationAnwenderdaten mit einer relativ hohen Geschwindigkeit mit Hilfe des Hauptkanals der Aufwärts-Leitung (200) zu übertragen, und eine zweite Sub-Modulationseinheit (24) enthält, um die Unterstation-Steuerinformationen mit eine-r relativ niedrigen Geschwindigkeit mit Hilfe des Hilfskanals der Aufwärts-Leitung (200) zu übertragen.

6. Verfahren zur Umschulung einer MODEM-Einheit in einer Unterstation eines Daten-Kommunikationsgerätes, bei dem eine Vielzahl von derartigen Unterstationen in einer multipoint-Art mit einer Hauptstation über eine Abwärts-Leitung (100) verbunden sind, die jeweils Haupt-und Hilfs-Kanäle enthält, um

Anwenderdaten und Steuerinforamtionen jeweils von der Hauptstation zu den Unterstationen zu übertragen, und mit einer Aufwärts-Leitung (200), die jeweilige Haupt-und Hilfs-Kanäle enthält, um Anwenderdaten und Steuerinformationen von den Unterstationen zu der Hauptstation zu übertragen, wobei das Verfahren die Schritte umfaßt:

Überwachen in der Unterstation, welche die genannte MODEM-Einheit (12-i) enthält, einer Abnormität in dem Abwärtsleitung-Signal, welches an der Unterstation empfangen wird und, wenn eine derartige Abnormität detektiert wird, Aussenden eines vorbestimmten Signals zur Hauptstation über den Hilfskanal der Aufwärts-Leitung (200), und
Durchführen einer Überwachung in der Hauptstation hinsichtlich des Empfangs eines derartigen vorbestimmten Signals über die Aufwärts-Leitung von einer der Unterstationen,
dadurch **gekennzeichnet**, daß das vorbestimmte Signal ein Umschulungs-Anfragesignal ist, welches anzeigt, daß die in Betracht stehende Unterstation ein Umschulungssignal von der Hauptstation anfragt, und welches durch die Unterstation er- (zeugt wird, wenn diese detektiert, daß die Abwärts-Leitung-Signalqualität unter einen vorherbestimmten Schwellenwert abgefallen ist,
und daß nach dem Empfang des Umschulung-Anfragesignals die Hauptstation automatisch ein derartiges Umschulungssignal über die Abwärts-Leitung zu den Unterstationen aussendet, um dadurch eine Umschulung der MODEM-Einheit auszulösen.

7. Verfahren nach Anspruch 6, wonach die Unterstation mit dem Umschulung-Anfragesignal Informationen aussendet, welche die Abnormität in der Abwärts-Leitung betreffen, die dadurch detektiert wurde, und
die Hauptstation die übertragenen Informationen als auch Informationen hinsichtlich der Umschulung-Ausführungszeit in den Unterstationen speichert und, wenn ein Umschulung-Anfragesignal von einer der Unterstationen empfangen wird, die gespeicherten Informationen ausliest, welche diese Unterstation betreffen, um daraus zu bestimmen, ob die Abwärts-Leitung normal ist oder nicht und, wenn dies der Fall ist, ein derartiges Umschulungs-Signals zu den Unterstationen über die Abwärts-Leitung zu senden, jedoch wenn dies nicht der Fall ist, das Umschulungssignal nicht auszusenden.

8. Verfahren nach Anspruch 7, wonach dann, wenn nachfolgend dem Empfang des Umschulung-Anfragesignals bestimmt wird, daß die Abwärts-Leitung anomal ist, die durch eine Unterstation gesendeten Informationen, welche die Abnormität betreffen, analysiert werden und die Ergebnisse der Analyse durch die Hauptstation ausgegeben werden.

9. Verfahren nach Anspruch 7 oder 8, wonach nachfolgend dem Empfang des Umschulung-Anfragesignals die Hauptstation aus den gespeicherten Informationen, welche die Abnormität-Feststellung in der einen Unterstation betreffen, bestimmt, ob diese eine Unterstation-Ausrüstung normal funktioniert oder nicht und, wenn die in Betracht stehende Ausrüstung als anomal funktionierend festgelegt wird, die Abnormität derselben anzeigt.

Revendications

1. Appareil de communication de données comprenant une station maître et une pluralité de stations esclaves raccordées en de multiples points à la station maître au moyen de lignes montantes et descendantes respectives (200, 100) ;

ladite station maître comprenant une première unité de Modem (10) raccordée pour recevoir des données d'utilisateur et des informations de commande à transmettre aux stations esclaves et utilisable pour moduler ces données d'utilisateur et ces informations de commande et pour appliquer les données d'utilisateur et les informations de commande modulées aux canaux principaux et auxiliaires respectifs de ladite ligne descendante (100), ladite première unité de Modem (10) étant aussi raccordée à ladite ligne montante (200) pour recevoir, via des canaux principaux et auxiliaires respectifs de celle-ci, des données d'utilisateur et des informations de commande modulées transmises par les stations esclaves à la station maître et étant utilisable pour démoduler les données d'utilisateur et les informations de commande reçues;
chacune desdites stations esclaves comprenant une seconde unité de Modem (12-i) raccordée à ladite ligne descendante (100) pour recevoir les données d'utilisateur et les informations de commande transmises aux stations esclaves par la station maître et utilisable pour démoduler ces données d'utilisateur et ces informations de commande, ladite seconde unité de Modem (12-i) étant aussi raccordée pour recevoir des données d'utilisateur et des informations de commande à transmettre par sa station esclave à la station maître et étant utilisable pour moduler ces données d'utilisateur et ces informations de commande reçues et pour appliquer les données d'utilisateur et les informations de commande modulées respectivement

auxdits canaux principaux et auxiliaires de ladite ligne montante (200) ; et
chacune desdites stations esclaves comprenant aussi un dispositif de détection d'anomalie (30) raccordée fonctionnellement à ladite seconde unité de Modem (12-i) de la station esclave concernée et utilisable, lors de la détection d'une anomalie dans le signal de ligne descendante reçu par la station esclave concernée, pour transmettre un signal prédéterminé à ladite station maître via ledit canal auxiliaire de la ligne montante ;
caractérisé en ce que ledit signal prédéterminé est un signal de demande de réinitialisation, indiquant que la station esclave concernée demande un signal de réinitialisation à partir de la station maître, produit lorsque ledit dispositif de détection d'anomalie (30) détecte que la qualité du signal de ligne descendante est tombée sous une valeur de seuil prédéterminée (Th0/Th1) ; et
en ce que la station maître comprend un dispositif de commande de réinitialisation (32) raccordé fonctionnellement à la première unité de Modem (10) et utilisable lors de la réception d'un tel signal de demande de réinitialisation d'une des stations esclaves pour provoquer la retransmission par la première unité de Modem d'un tel signal de réinitialisation via ladite ligne descendante.

2. Appareil de communication de données selon la revendication 1, dans lequel ladite station maître comprend en outre un dispositif de stockage (32) pour stocker des informations d'enregistrement passées concernant une détection d'anomalie dans les stations esclaves et des informations sur l'instant d'exécution de la réinitialisation, obtenues via la première unité de Modem ;
ledit dispositif de commande de réinitialisation (32) étant utilisable pour se référer au dispositif de stockage lors de la réception d'un tel signal de demande de réinitialisation et, sur la base des informations d'enregistrement passées lors de la réinitialisation, pour déterminer si oui ou non il devrait provoquer une transmission du signal de réinitialisation.

3. Appareil de communication de données selon la revendication 2, dans lequel ledit dispositif de commande de réinitialisation (32) comprend un dispositif pour rejeter un tel signal de demande de réinitialisation lorsqu'il est reçu avant que le temps nécessaire pour une réinitialisation précédente se soit écoulé, ou lorsque la station maître reçoit une pluralité de signaux de demande de réinitialisation à partir d'une station esclave particulière.

4. Appareil de communication de données selon l'une quelconque des revendications précédentes, dans lequel ledit dispositif de détection d'anomalie (30) comprend un circuit de surveillance (302) pour surveiller la présence ou l'absence d'une anomalie dans la ligne descendante et un dispositif de commande (300) sensible à un signal de sortie du circuit de surveillance, indiquant la présence d'une anomalie, pour provoquer la transmission par la seconde unité de Modem (12-i) de la station esclave concernée du signal de demande de réinitialisation à la station maître.

5. Appareil de communication de données selon l'une quelconque des revendications précédentes, dans lequel :

ladite première unité de Modem (10) comprend une première unité de modulation principale (14) pour transmettre de telles données d'utilisateur de station maître à un débit relativement élevé au moyen dudit canal principal de la ligne descendante (100), une première unité de sous-modulation (16) pour transmettre des telles informations de commande de station maître à un débit relativement faible au moyen dudit canal auxiliaire de la ligne descendante (100), une première unité de démodulation principale (26) pour démoduler de telles données d'utilisateur de station esclave à partir d'un signal de modulation reçu via ledit canal principal de la ligne montante (200), et une première unité de sous-démodulation (28) pour démoduler de telles informations de commande de station esclave à partir d'un signal de modulation reçu via ledit canal auxiliaire de la ligne montante (200), et
chacune desdites secondes unités de Modem (12-i) comprend une seconde unité de démodulation principale (18) pour démoduler les données d'utilisateur de station maître à partir d'un signal de modulation reçu via le canal principal de la ligne descendante (100), une seconde unité de sous-démodulation (20) pour démoduler les informations de commande de station maître à partir d'un signal de modulation reçu via ledit canal auxiliaire de la ligne descendante (100), une seconde unité de modulation principale (22) pour transmettre les données d'utilisateur de station esclave à un débit relativement élevé au moyen du canal principal de la ligne montante (200), et une seconde unité de sous-modulation (24) pour transmettre les informations de commande de station esclave à un débit relativement faible au moyen dudit canal auxiliaire de la ligne montante (200).

6. Procédé de réinitialisation d'une unité de Modem dans une station esclave de l'appareil de commu-

nication de données dans lequel une pluralité de ces stations esclaves sont raccordées en de multiples points à une station maître au moyen d'une ligne descendante (100), ayant des canaux principaux et auxiliaires respectifs pour transmettre des données d'utilisateur et des informations de commande respectivement de la station maître aux stations esclaves, et une ligne montante (200) ayant des canaux principaux et auxiliaires respectifs pour transmettre des données d'utilisateur et des informations de commande des stations esclaves à la station maître, lequel procédé comprend :

dans la station esclave ayant ladite unité de Modem (12-i), la surveillance d'une anomalie dans le signal de ligne descendante reçu par la station esclave et, si une telle anomalie est détectée, transmission d'un signal prédéterminé à la station maître via ledit canal auxiliaire de la ligne montante (200) ; et
dans ladite station maître, surveillance de la réception via ladite ligne montante d'un tel signal prédéterminé à partir des stations esclaves ;
caractérisé en ce que ledit signal prédéterminé est un signal de demande de réinitialisation, indiquant que la station esclave concernée demande un signal de réinitialisation à la station maître, et est produit par la station esclave lorsqu'elle détecte que la qualité du signal de ligne descendante a chuté en dessous d'une valeur de seuil prédéterminée ;
et en ce que lors de la réception dudit signal de demande de réinitialisation la station maître transmet automatiquement un tel signal de réinitialisation via la ligne descendante aux stations esclaves, pour provoquer ainsi la réinitialisation de ladite unité de Modem.

7. Procédé selon la revendication 6, dans lequel :

la station esclave transmet avec le signal de demande de réinitialisation des informations concernant l'anomalie dans la ligne descendante détectée par celle-ci ; et
la station maître stocke les informations transmises, ainsi que des informations sur l'instant d'exécution de la réinitialisation dans les stations esclaves, et, lorsqu'un signal de demande de réinitialisation est reçu par une des stations esclaves, lit les informations stockées concernant cette station esclave pour déterminer à partir de celles-ci si oui ou non la ligne descendante est normale et, si il en est ainsi, transmet ce signal de réinitialisation aux stations esclaves via la ligne descendante mais, si non, ne transmet pas le signal de réinitialisation.

8. Procédé selon la revendication 7, dans lequel, si, après la réception du signal de demande de réinitialisation, on détermine que la ligne descendante est anormale, les informations transmises par ladite station esclave concernant l'anomalie est analysée et les résultats de l'analyse sont fournis par la station maître.

9. Procédé selon la revendication 7 ou 8, dans lequel après la réception du signal de demande de réinitialisation, la station maître détermine aussi à partir des informations stockées concernant la détection d'anomalie dans ladite station esclave si oui ou non ledit équipement de station esclave fonctionne normalement et, lorsqu'on détermine que l'équipement concerné fonctionne anormalement, indique l'anomalie de celui-ci.

Fig. 1

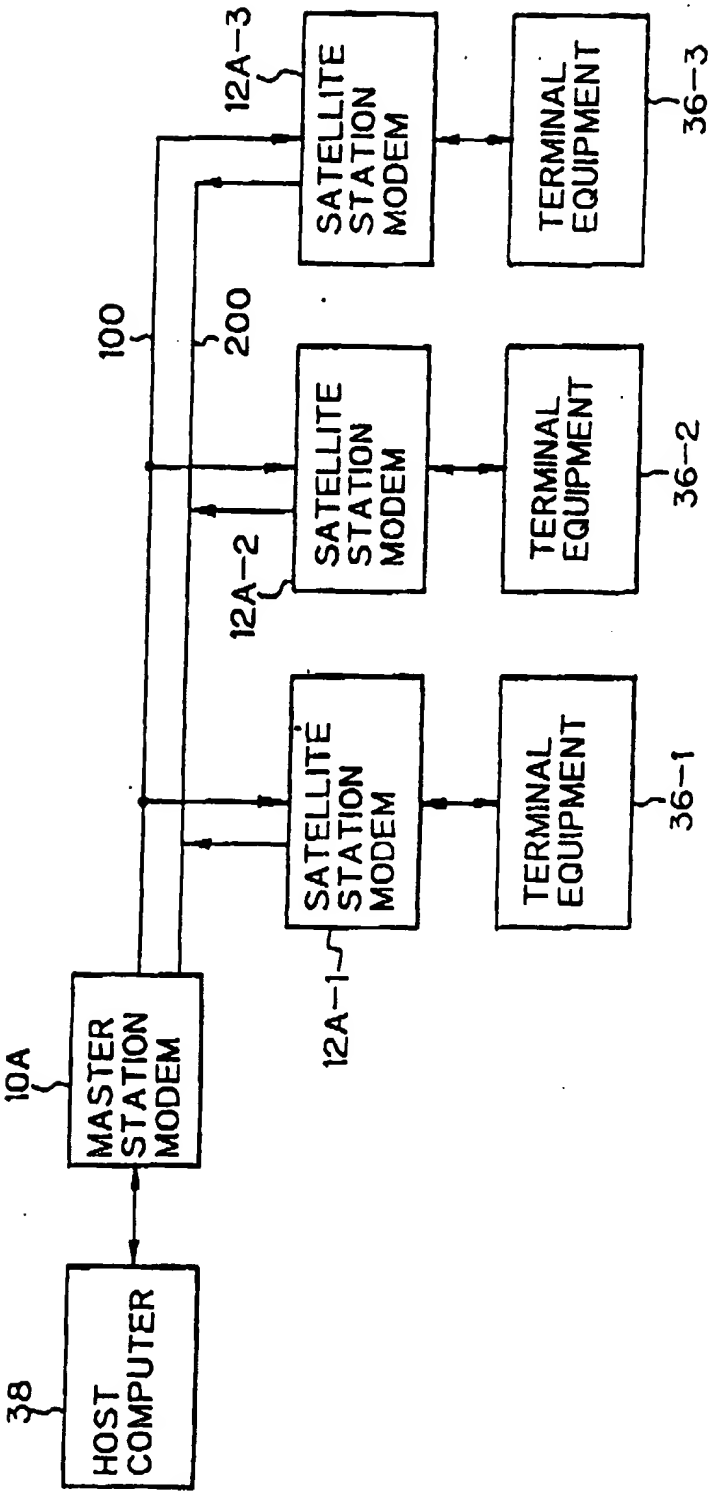
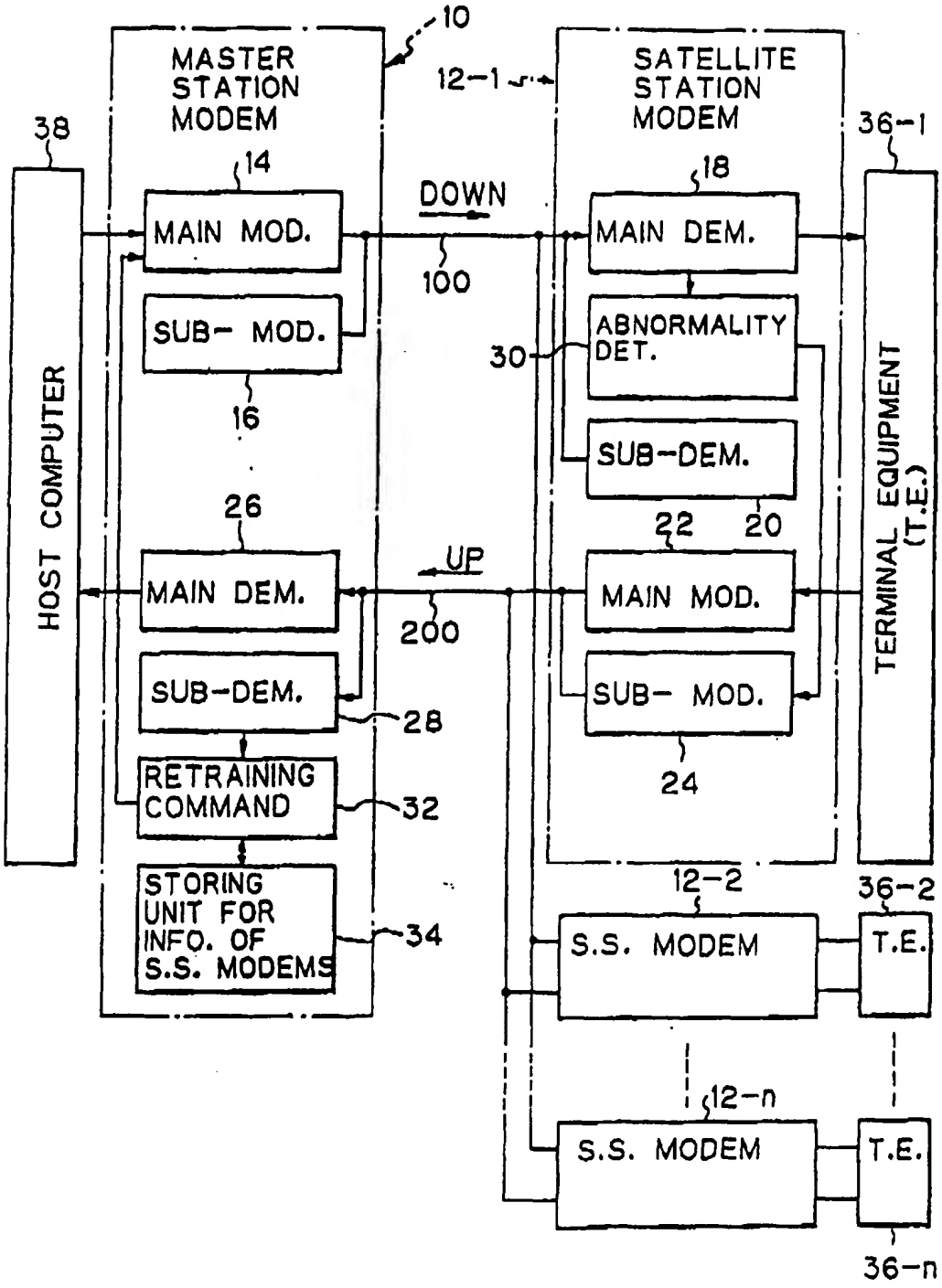

HOST COMPUTER
38
MASTER STATION MODEM
10A
100
200
SATELLITE STATION MODEM
12A-1
12A-2
12A-3
TERMINAL EQUIPMENT
36-1
36-2
36-3

Fig. 2


10
MASTER STATION MODEM
12-1
SATELLITE STATION MODEM
38
36-1
14
18
DOWN
MAIN MOD.
MAIN DEM.
100
SUB- MOD.
ABNORMALITY DET.
30
16
SUB-DEM.
22
20
26
UP
MAIN DEM.
MAIN MOD.
200
SUB-DEM.
SUB- MOD.
28
24
RETRAINING COMMAND
32
STORING UNIT FOR INFO. OF S.S. MODEMS
34
HOST COMPUTER
TERMINAL EQUIPMENT (T.E.)
12-2
36-2
S.S. MODEM
T.E.
12-n
S.S. MODEM
T.E.
36-n

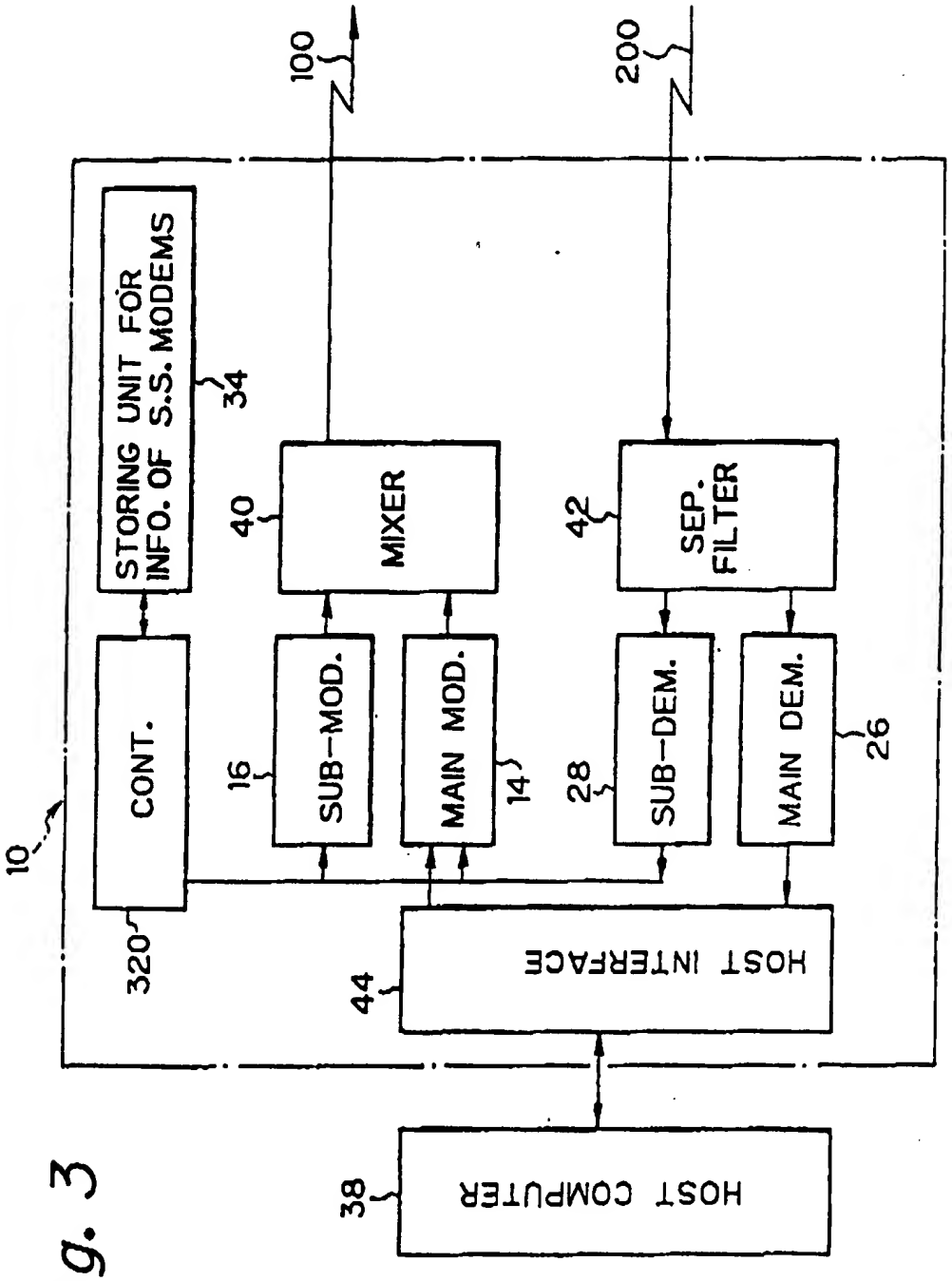

100
200
STORING UNIT FOR INFO. OF S.S. MODEMS
34
40
MIXER
42
SEP. FILTER
CONT.
SUB-MOD.
16
MAIN MOD.
14
SUB-DEM.
28
MAIN DEM.
26
10
320
HOST INTERFACE
44
HOST COMPUTER
38

Fig. 3

Fig. 4

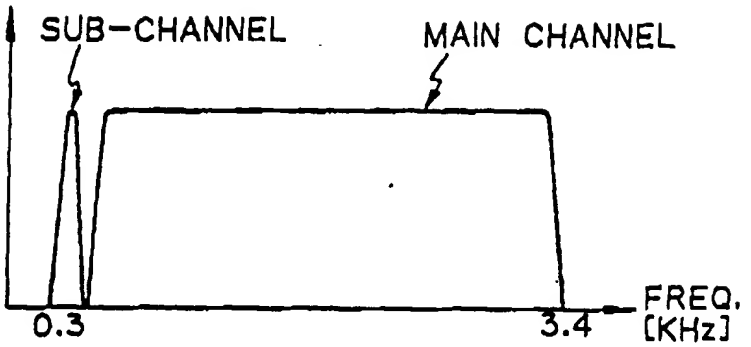

SUB-CHANNEL
MAIN CHANNEL
0.3
3.4
FREQ. [KHz]

Fig. 5

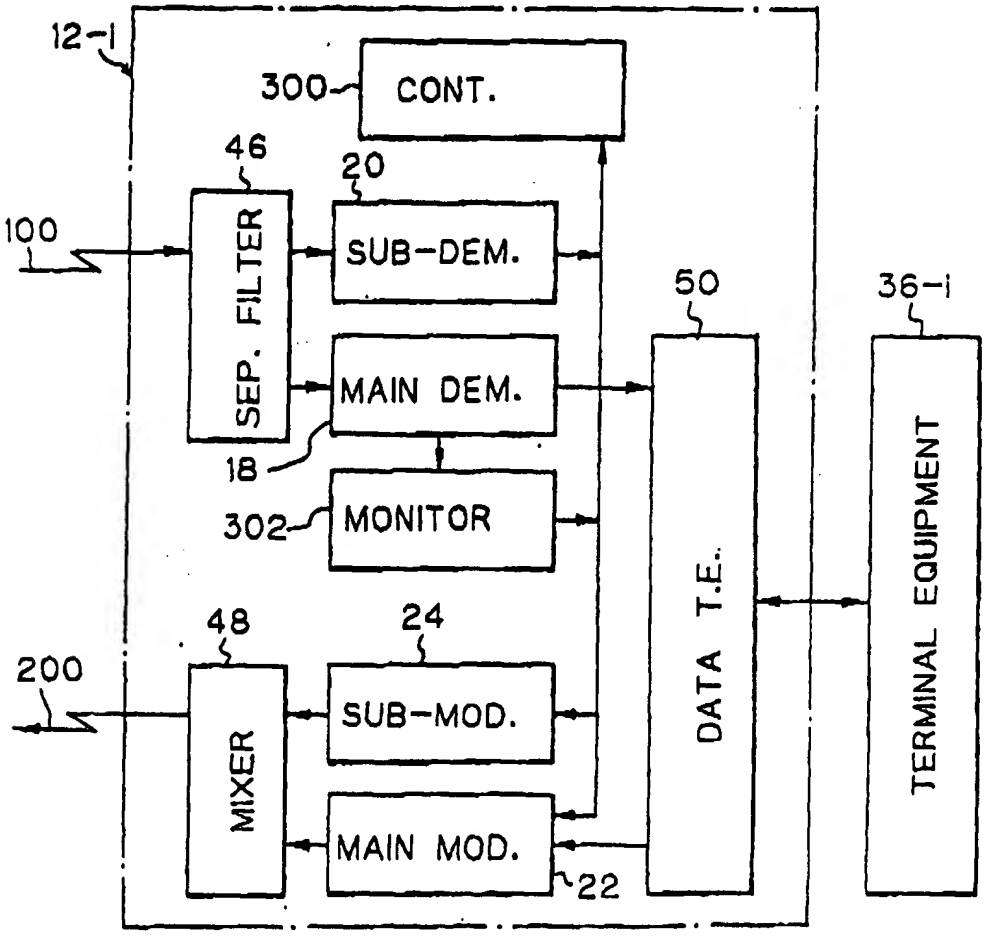

12-1
300
CONT.
46
20
100
SEP. FILTER
SUB-DEM.
50
36-1
MAIN DEM.
18
302
MONITOR
48
24
200
MIXER
SUB-MOD.
DATA T.E.
TERMINAL EQUIPMENT
MAIN MOD.
22

Fig. 6

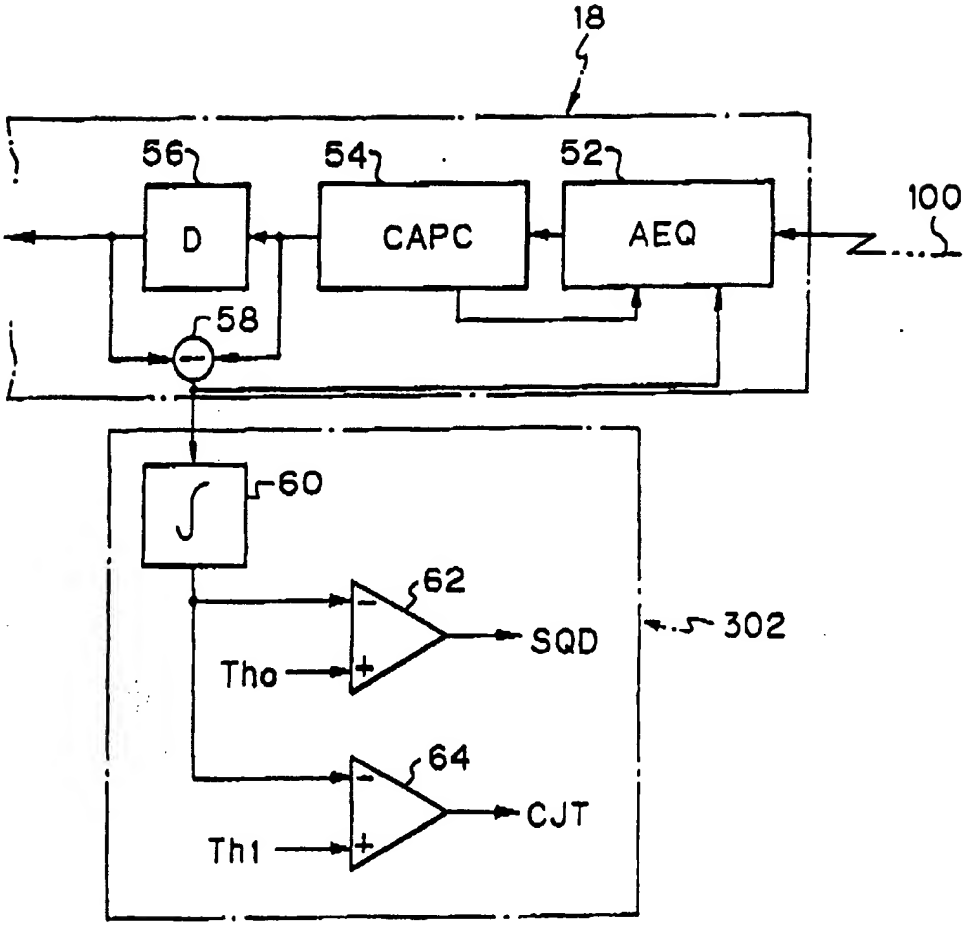


Fig. 7

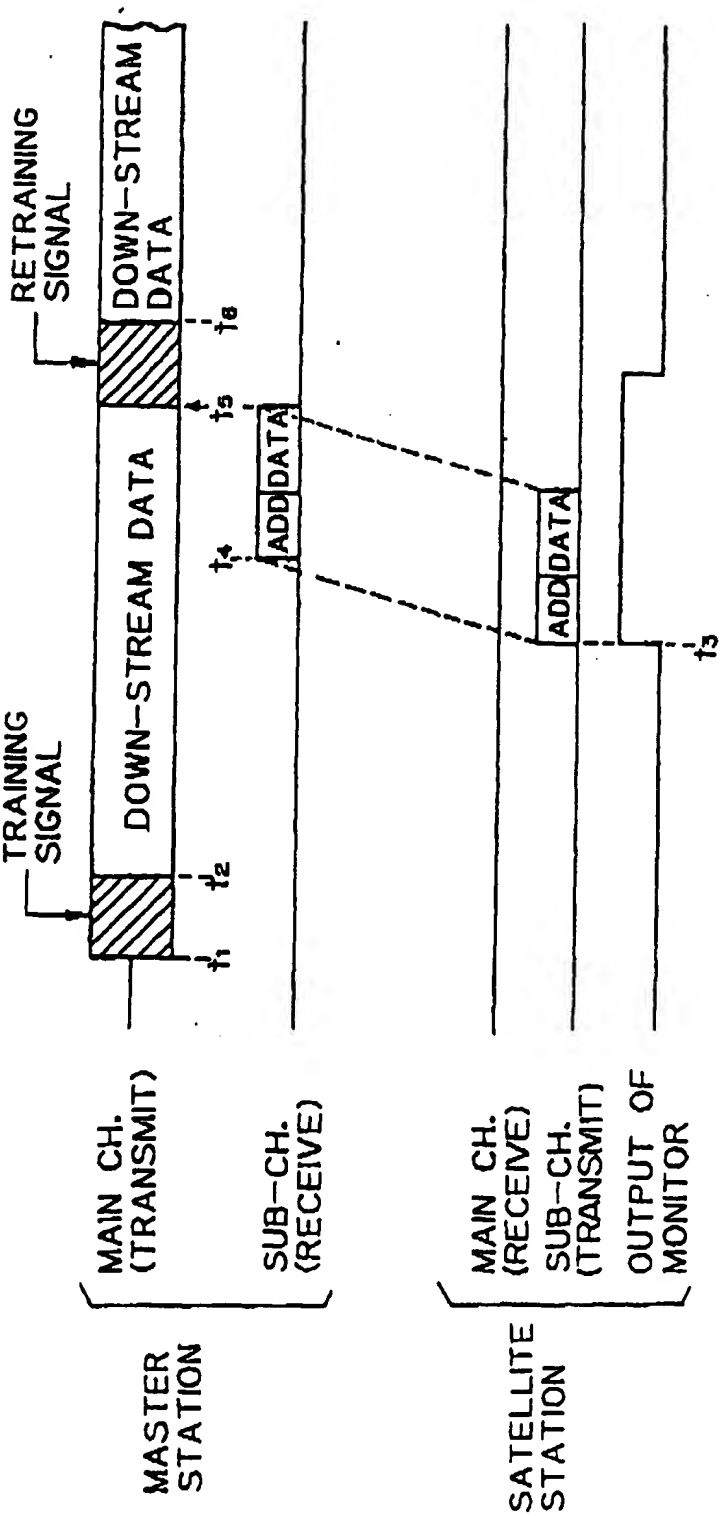

MASTER STATION
SATELLITE STATION
MAIN CH. (TRANSMIT)
SUB-CH. (RECEIVE)
MAIN CH. (RECEIVE)
SUB-CH. (TRANSMIT)
OUTPUT OF MONITOR
TRAINING SIGNAL
RETRAINING SIGNAL
DOWN-STREAM DATA
DOWN-STREAM DATA
ADD DATA
ADD DATA
t1
t2
t3
t4
t5
t6

Fig. 8A

Fig. 8

Fig. 8A

Fig. 8B

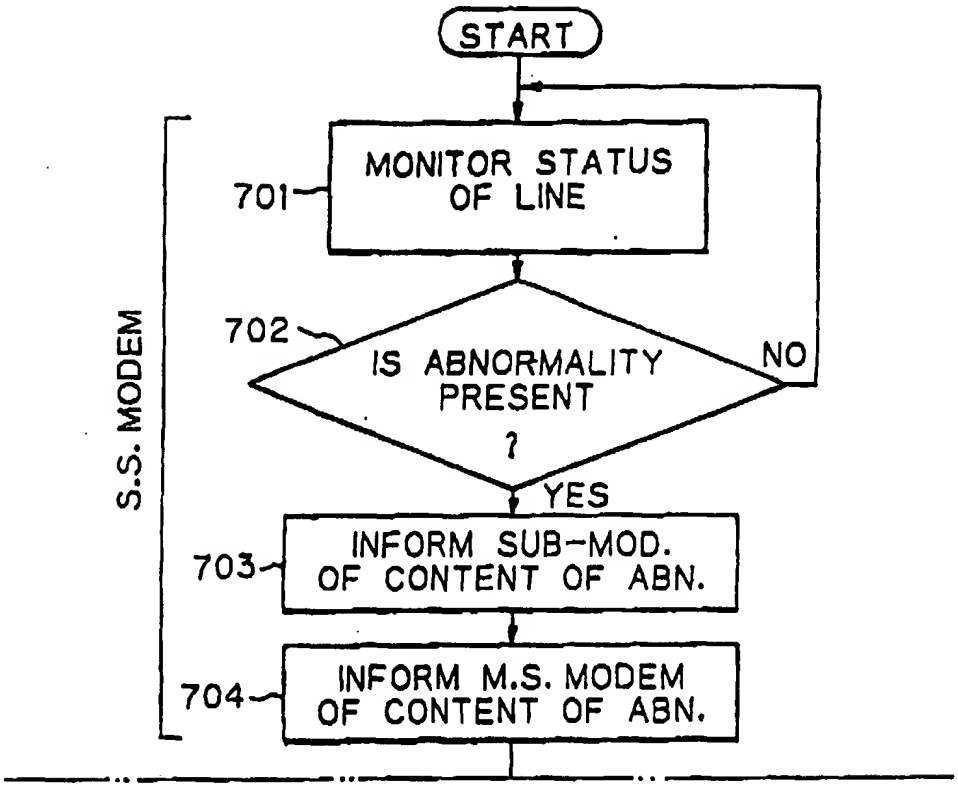
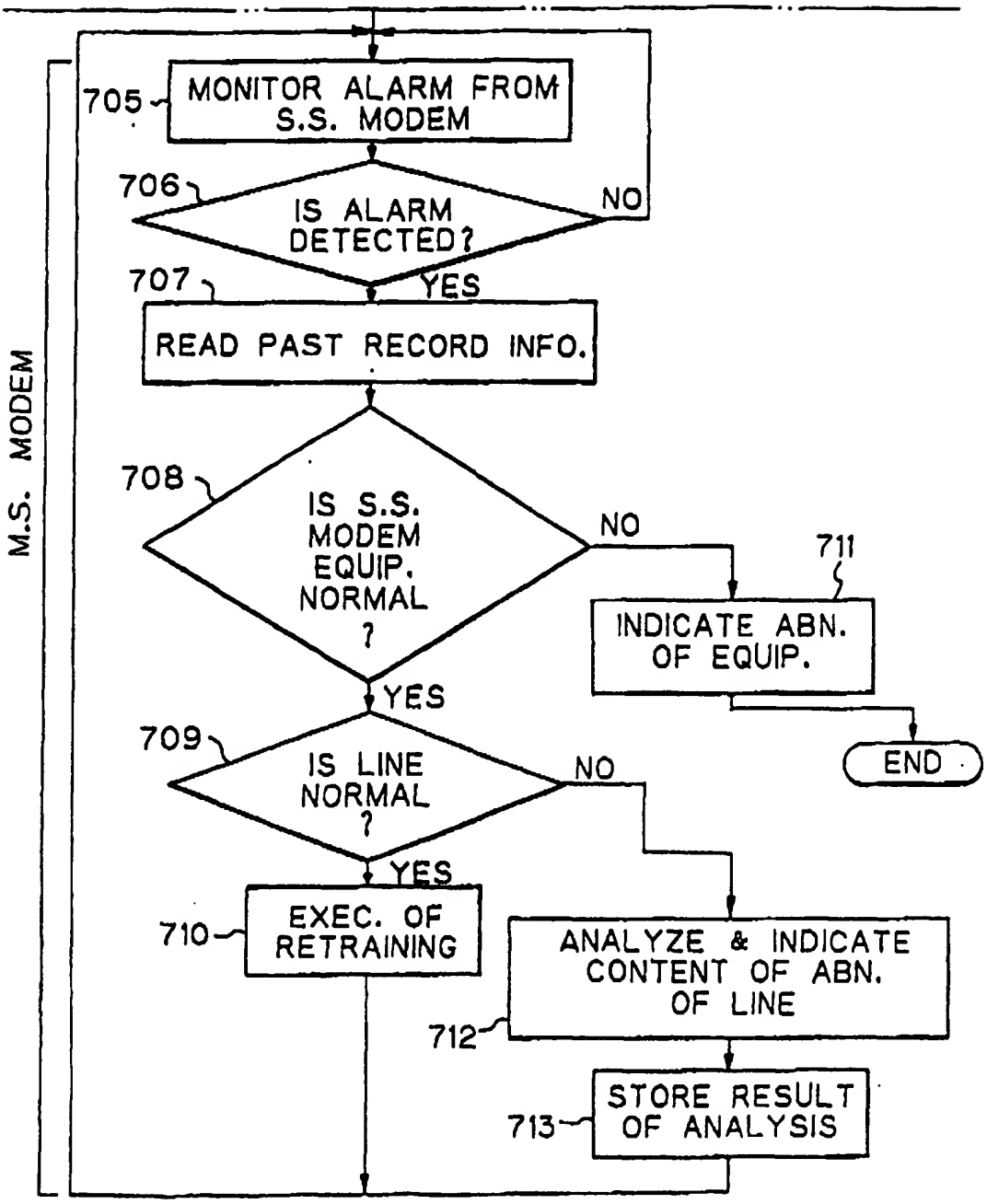


Fig. 8B


M.S. MODEM
705
MONITOR ALARM FROM S.S. MODEM
706
IS ALARM DETECTED?
NO
YES
707
READ PAST RECORD INFO.
708
IS S.S. MODEM EQUIP. NORMAL ?
NO
711
INDICATE ABN. OF EQUIP.
END
YES
709
IS LINE NORMAL ?
NO
YES
710
EXEC. OF RETRAINING
ANALYZE & INDICATE CONTENT OF ABN. OF LINE
712
713
STORE RESULT OF ANALYSIS